SEARCH AND RESCUE METHOD AND SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a U.S. national stage application under 35 U.S.C. 371 of co-pending International Application No. PCT/US11/33785 filed on Apr. 25, 2011 and entitled SEARCH AND RESCUE METHOD AND SYSTEM, which in turn claims priority to U.S. Provisional Patent Application No. 61/327,362 file don Apr. 23, 2010, and U.S. Provisional Patent Application No. 61/372,541 filed on Aug. 11, 2010, all of which are incorporated by reference herein in their entirety for all purposes.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with government support under Contract No. NIJ 2003-U-CX-K-025 awarded by The National Institute of Justice. The government has certain rights in the invention.

BACKGROUND OF THE INVENTION

Embodiments of the present invention deal with a low cost effective system for locating missing objects such as fire fighters, first responders, miners, divers and the like in a hard to see location such as through walls, smoke and under debris and the like during a fire fighting operation, a mine, underwater and the like.

It is extremely difficult to find objects such as fire fighters in an environment such as a smoke filled building which has maze like layouts and underground passages. Some prior radio-based homing systems require the user to move over a large arc and to keep track of the changes in signal strength during this motion to deduce the possible location of the target via a non-intuitive process, while others have little ability to penetrate building materials such as aluminium siding and concrete with metal reinforcement. Furthermore, this process can be thwarted by changes in the position/orientation of the target and by metallic content in the building.

In a review of almost 3,400 US firefighter Line of Duty Deaths (hereinafter "LODD") between 1977 and 2006 (Firefighter Fatalities Studies 1977-2006, NFPA Journal, July/August 2007, Fahey et al.), deaths due to traumatic injury while operating inside structures have shown little improvement over the time period, when corrected for the change (decline) in the number of structural fires. Indeed this observation is borne out again as "In 2008 One-hundred and eighteen (118) firefighters died while on duty in 2008, the same number of firefighter fatalities as the previous year," according to the U.S. Fire Administration's report "Firefighter Fatalities in the United States in 2008" published in September 2009.

An analysis of the 102 firefighter LODDs in 2007 (Firefighter Fatalities in the United States—2007, NPFA, July 2008, Fahey et al), shows that, after cardiac events (40) and being struck by an object (32), the leading cause of death was being caught or trapped on the fire ground, accounting for 23 of the 102 fatalities. The situation is even more serious for the career firefighter for whom deaths due to being lost or trapped were 43% of total deaths, whereas they represented only 5% of volunteer deaths.

SUMMARY OF THE INVENTION

The search and rescue system and method (a.k.a. Mantenna™ at certain times during the description of various embodiments of the invention) is in certain embodiments a low cost firefighter-deployed directional through-wall homing device that can be used to achieve speed-up of rescue operations in, for example, a smoke filled fire. The search and rescue system uses novel designs of both the transmit and receive antennas, novel signalling scheme, and signal processing algorithms or methods to provide distance and direction information leading to the, for example, fallen fire-fighter regardless of the orientation of the fallen fire-fighter's transmitter unit or the distance of the receiver from the unit. The range and direction information is available at any moment to the rescuer. This approach is a significant improvement on avalanche locators and other commercial fire-fighter radio based location systems, which simply use ordinary "radio direction finding".

The very low frequency (VLF) near field radio signals used by the search and rescue system of this embodiment have properties such that metal and most other objects in a building have relatively low impact on the Near Field component of the radio signal, unlike the Radiation field component which is commonly used by radio location and other homing systems. This property makes the use of Near Field ideal for use in nearly any type of building which exists today, even fully metallic buildings.

The intended application of the search and rescue system is to reduce the number of injuries and Line of Duty Deaths (LODDs) of, for example, fire fighters from traumatic injuries while operating inside structures, especially those due to burns, smoke inhalation, stress, and becoming lost, trapped or being enmeshed by a collapsed building. The goal of this project is motivated by findings of several studies that connect Line of Duty Deaths with traumatic injuries while operating inside structures.

More specifically set forth below are descriptions of the various embodiments of the system and method of this invention.

One of the embodiments of the present invention provides for a method which can be used for search and rescue by locating a transmitter using a receiver which includes the steps of transmitting a plurality of distinctive and orthogonally polarized signals from a transmitter; receiving the transmitted signals at a pair of separated antennas; demodulating the distinctive orthogonal signals received at each of the pair of separated antennas; and determining a direction to the transmitter from the signals received at the pair of antennas. More particularly, the following steps further implement the search and rescue method described above, for example the step of determining includes combining signal amplitude levels of the demodulated signals received for each respective antenna of the pair of separated antennas and indicating to a user the difference between the combined signal amplitude levels from the separated antennas or some function of that difference. The step of determining includes using received noise levels for adjusting the combined signal amplitude levels and the step of determining can also include aligning the pair of antennas to maximize the difference between the combined signal amplitude levels of the pair of antennas to estimate a direction to the transmitter. The method further can include the step of estimating a distance to the transmitter from the receiver from the difference in the combined signal amplitude levels and wherein the step of transmitting uses three orthogonally polarized signals or uses three magnetic dipole antennas or three